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1. Introduction

Mindful organising is a key integrating concept in resolving the organisational accident. It represents the sense-making role of people at the operational sharp end. Mindful organising is both the unique source of critical information about the normal operation (i.e. what went well -actions that were effective and are shared and what could be improved), as well as the key recipient of intelligence about the operation, ensuring that operational actions are always informed by the most current, relevant information about potential risks no matter how remote. It is this circulation of information and knowledge throughout the organisation that is at the heart of the original conception of organisational mindfulness of Weick and Sutcliffe, but which has never been operationalised as a practical and effective approach for complex ultra-safe systems. This paper builds on a sister paper (Callari, McDonald, Kirwan, Cartmale, 2019) in a two stage argument about how to address this shared problem statement:

What should an organisation do in practice to be mindful? How is this ability (of detecting early warning signals, and coping resiliently with unexpected events) concretely enacted and undertaken within organisations? Does the mindful organising construct and its underlining characteristics provide clear guidance on how to implement it?

Callari et al. (2019) provide a detailed analysis of the way in which core mindful organising concepts are understood and acted on within an Air Traffic Control Organisation. This paper joins this with a complementary case study of Airline ground operations, focussing on an analysis of operational audits and the management of safety information. Both of these case studies provide a basis for exploring a set of practical organisational principles that could underpin a of Mindful Governance model. These principles are operationalised in a way that addresses the issues that come out of both case studies, and this operationalisation in turn suggests ways in which Mindful Governance could be enhanced and supported by some simple applications.

2. Literature review

Mindful organising enables individuals to continuously interact with others in the organisation as they develop shared understanding of the situation they encounter and their capabilities to act. This collective capability support the detection/identification of unwanted safety-related events, and the prevention of possible errors (Sutcliffe, 2011; Vogus & Sutcliffe, 2012; Weick, 2015b; Weick & Sutcliffe, 2015). The importance of regular communication is emphasised as it is seen as an enabler of trust and building of joint action. "*These patterns of interrelating are as close to a physical substrate for collective mind as we are likely to find. There is nothing mystical about all this. Collective mind is manifest when individuals construct mutually shared fields*" (Weick & Roberts, 1993, p. 365)

The individual's understanding of the interrelationships between parts (his/her contribution) and whole (his/her contribution into forming a larger whole) forms a larger pattern of shared action (i.e. cognitive dimension of social capital) (Sutcliffe, Vogus, & Dane, 2016; Weick, 2015a). Mindful organising exists

when it is collectively enacted, when a set of behaviours are enacted triggered by shared perceptions of similar levels of behaviours. This is also sustained by task interdependence or time working together, which can facilitate the homogenizing effects of social influence and social learning by offering ongoing opportunities for work-related interactions (Vogus, 2011; Vogus & Sutcliffe, 2012). Three claims characterize the concept: (1) it results from bottom-up processes; (2) it enacts the context for thinking and action on the front line; and (3) it is relatively fragile and needs to be continuously re-accomplished (Vogus & Sutcliffe, 2012). The ability to adjust the organization of work as well as procedures is seen as an important enabler of reliability. Mindful organising thus includes the ability to recognise that the way of working must be adapted to current conditions, rather than relying on pre-defined organizational structures (Weick, Sutcliffe, & Obstfeld, 1999a, 1999b).

Mindful organising requires the achievement of (i) respectful interaction (ii) heedful interrelations, and (iii) mindful infrastructure (Weick, 2015a). The path to a mindful infrastructure comprises five processes of collective capability (Weick & Putnam, 2006; Weick & Sutcliffe, 2007; Weick et al., 1999b): (1) preoccupation with failure; (2) reluctance to simplify interpretations; (3) sensitivity to operations; (4) commitment to resilience; and (5) under-specification of structure (Weick, 2015b). These five principles are also considered as the foundations to mindful practices within the organisation, which preserve system resilience in the face of change (Weick, 2015d).

In Sutcliffe and colleagues' latest work (Barton & Sutcliffe, 2009; Barton, Sutcliffe, Vogus, & DeWitt, 2015; Beck & Plowman, 2009; Becke, 2013; Vogus & Sutcliffe, 2012) more attention has been put in specifying the roles that top managers, middle managers and operational people have in promoting mindful organising in the organisation. As such, the challenge is in connecting these three groups and finding ways to translate and share information across the various 'layers'. By definition, this goes beyond the classic operational focus of Human Factors, whether it be situational awareness (Endsley, 1995; Endsley & Jones, 2001), team working (Salas, Reyes, & McDaniel, 2018; Salas, Rico, & Passmore, 2017) or joint cognitive models (Hollnagel & Woods, 1983, 2005; Hollnagel, Woods, & Leveson, 2006), amongst many others. It requires attention to the specific roles and functions of management in relation to the operation. To use Mintzberg's (1983) terms, these include the diverse roles of the middle line of management up to the strategic apex, as well as the planning, training, operations research, scheduling, and standardisation functions of the 'technostructure', including quality and safety management. It also includes cross-functional activities, like the management of change, which is often experienced as highly challenging and demanding by managers with a dual responsibility for maintaining stability and operational performance at the same time as introducing new ways of working (Corrigan & McDonald, 2015; Corrigan et al., 2015; McDonald, 2015).

In the organisational hierarchy the groups which contribute to mindfulness/mindful organising are: (1) top administrators; (2) middle managers; (3) front-line employees (Vogus and Sutcliffe, 2012). In their work, Vogus and Sutcliffe (2012) suggest that top administrators are the ones in charge of the strategic issues in an organisation, and as such to the related organisational mindfulness (and as such, it takes a top-down approach (Ray, Baker, & Plowman, 2011). The literature in field has often highlighted the role played by top managers/CEO in running their businesses profitably, and – at the

same time – keeping them safe from threats (Makins et al., 2016). This includes the resources and commitment that both top managers and the overall organisation put in place to support safety management and improvements (Fruhen, Mearns, Flin, & Kirwan, 2014a, 2014b; Tappura, Nenonen, & Kivistö-Rahnasto, 2017; Zuofa & Ocheing, 2017; Zwetsloot et al., 2017).

On the other hand, very little has been explored about the role played by middle managers in keeping safety in every organisational operation. Vogus and Sutcliffe (2012) argue that middle managers are the actors bridging organisational mindfulness and mindful organising. As perception of organisational mindfulness of top administrators (i.e. top administrators' continuous scanning of information and on the fringes of current operations) might not coincide with the information at the front-line (front-line employees' mindful organising) the middle managers (such as technical department heads) play a crucial role in linking the top and the bottom of an organisation. As "reliability professionals" the middle managers play a crucial role in creating organisational mindfulness by reconciling the need for anticipation and careful causal analysis with the need for flexibility and improvisation in the face of unexpected change. They act as "translators" of real-time data from the front lines for the top administrators and creating structures that can guide front line actions (Roe & Schulman, 2008). In a recent research, Callari, Bieder and Kirwan (2019) conducted an extensive research involving 48 middle managers from the European civil aviation industry. They suggest that the practices middle managers identify as central in relation to their role in the management of safety can be grouped in three high-level categories: 'Managing information', 'Making Decisions', and 'Influencing Others'. All the three practices constitute the distinctive and idiosyncratic competency that middle manager rely on to get the job done when it comes to contributing to safety.

Front-line employees – as the "HROs bringing-knowledge people with the greasy hands" are the crucial actors able to detect/anticipate the weak signals and the possible threats to reliability. Front-line operators face high variability and uncertainty in their task environment and are required to recognise and act on emerging and weak signals, which could necessitate the need to identify and analyse often obscure interdependencies (Dijkstra, 2013; Flin & O'Connor, 2013; Frigotto & Zamarian, 2015; Guiette, Matthyssens, & Vandenbempt, 2014; Klockner, 2018; McDonald, Callari, Baranzini, Woltjer, & Johansson, 2015; McDonald et al., 2016; Sutcliffe & Vogus, 2014; Weick & Roberts, 1993; Weick & Sutcliffe, 2007; Weick, Sutcliffe, & Obstfeld, 1999). As such they will enhance both process and occupational safety, the environment and health along with reliability, productivity and commercial performance (mindful organising) (Vogus and Sutcliffe, 2012).

Vogus and Sutcliffe (2012) suggest that mindful organising needs to operate across organizational levels to produce strategic and operational reliability. Organizational mindfulness shall be created by top managers, synchronized across levels by middle managers, and translated into mindful organising actions on the front line.

3. Advancing the Mindful Governance model

When we examine the 5 mindfulness principles their reference point is (not surprisingly) characteristics of the 'state of mind' of actors/agents, particularly at the operational level. For Weick

this is a continuous social process of conversation, sharing, leading to sensemaking at individual and collective levels. He emphasises the spontaneous self-organising aspects of this, but these also require opportunities within the operational structure of everyday life. In the analysis of mindful organising in an ATC organisation (Callari, et al. 2019) it is clear that while some of these opportunities exist and are well supported, changes within the organisation (particularly around training and shift handovers) were perhaps constraining these opportunities. Secondly, when one examines the dominant flows of safety information, it becomes clear that the predominant flows of information are from the local operation to the administrative centre and that flows from centre to periphery are rather attenuated. Several conclusions follow from this analysis.

Mindful organising does not occur in an organisational vacuum. It is influenced by organisational structures and management processes as well as by the values represented by the five oft-cited mindfulness principles. Or, to put it another way, those principles are expressed (often imperfectly and in part) through the opportunities created by organisational structures and management processes.

Secondly, when one lifts the analysis from a particular operational context to the organisation as a whole (or even to the level of a multi-organisational extended operational system, as in aviation), this raises questions about the flow of information across all relevant parts of the system, including feedback loops and other properties of the (ideally) circular flow of information that serves to validate information and the expression of knowledge.

How can we enable and ensure that the recreation of mindfulness in fact leads to appropriate action, as distortions can occur and local contextual factors can often obscure the 'big picture'? How is it possible to learn from the link between mindfulness and activity and share widely those lessons?

This in turn implies that we need to build a system that gathers, shares and validates information (from mindful activity), enhancing knowledge and making it available to stimulate further mindful activity. What are the design principles for mindful organising?

This is what gave rise to the Mindful Governance model.

Overall, it is argued that a collaborative concept of organizational mindfulness is required – creating a purposeful flow of information that actively supports people's capability to act to fulfil their particular role and authority. This can include diverse operational roles – as crew, managing traffic, providing services at a port, airport or other infrastructural juncture. It includes diverse management roles, from supervising and managing the operation to planning, performance management, delivering human and other resources, managing safety, auditing, amongst many others. This is the basis of the principle of 'Distributed Authority' – authority to act is distributed throughout an organization and this needs to be actively supported to ensure a safe and effective organization. However it is not enough just to act with best intentions, those actions need to have the consequence of an improved functioning of the operation. Good governance requires that this is done in an accountable way – that actions done to ensure safety are transparently in conformity with best practice and in turn contribute to best practice - actions and their consequences need to be made transparent. Those with specific responsibilities for safety should be fully in the loop so that this becomes an integral part of the

organisation's capability for safety. This is not just an operational loop in relatively short real time, but involves a longer time frame of multiple operations, overall system performance and extended processes to change and improve the operation. Because of this wider spatial and temporal frame of reference, the visibility and accountability of action by all those various roles in the system becomes a critical organising concept. Distributed Authority and Accountability are two sides of the same coin make possible a self-regulatory system of governance capable of constantly improving its standards of performance. The value that is delivered may concern safety, operational effectiveness, efficiency or sustainability of the service delivered to the customer. In summary, good governance actively supports the Authority of all to act to fulfil their responsibilities that is distributed throughout the system, in order to achieve Value in improved and more reliable system performance, at the same time reinforcing Accountability for such actions in the control of risk.

In summary, self-regulation depends on the different aspects of the socio-technical system working together to create the conditions that support effective implementation both in normal routine operations and in improvement initiatives where issues arise that require some adjustment or change to the system. The flow of information and the sharing and transformation of knowledge that is fully grounded in real operational constraints represent a core enabler of both of these activities (normal operations and improvement). This information and knowledge needs not only to be relevant to the situation at hand, but it also needs to be configured in such a way as to enable and inform appropriate action – most particularly when this action goes beyond routine performance to managing an unusual situation or engendering a transformation of understanding. This requires nurturing by supportive social relations: both good co-ordination and leadership across relevant operational units, as well as amongst management groups and teams dedicated to improvement. Clear and effective operational and management processes can provide an institutional governance structure enabling accountability for all this activity and its outcomes across all the operational linkages between interdependent service processes. This requires an escalation of understanding horizontally across the interfaces of these interdependent operational processes, and vertically from the operational level, through the lines of accountable management to the strategic management of the organisation and thence to the regulating authority.

One way of describing this self-regulatory governance model is in terms of a process, a mechanism and an outcome. Taking these in reverse order, the outcome concerns the value produced – the creation of mindful and improved operations. The mechanism concerns the way in which information is produced, circulated, transformed and put to work. The process is the sequence of activities and stages through which an initial state (e.g. identification of a problem) is transformed into the final state (the implementation of a better way of working or a successful solution).

We have defined Value in terms of improved and more reliable system performance. There are actually three levels at which we can describe this value: Each successful improvement initiative delivers its own potential value; the reproducibility of successful change initiatives creates a sustainable value that derives from the embedding of the process and its information flows in the social organization; this in turn creates a knowledge base that creates the capacity to speed up the

learning – reflecting on what has worked in the past together with more profound knowledge of how the system functions can enable more powerful solutions implemented more effectively. This is a kind of 'double-loop learning' (Argyris & Schön, 1996). The aim is to enable an exponential virtuous cycle of value creation.

Closing the loop of action or implementation in this way is what demonstrates value from an improved operation – greater reliability, functioning more effectively. This value may be expressed in terms of safety, but equally it is applicable to dimensions of quality, cost of service, environmental impact etc. In fact this approach lends itself to an integrated strategic risk management framework in which all significant risks to an operation are analysed and prioritized; potential conflicts and synergies can be addressed; responsibility for agreed programmes of action can be allocated, with clear accountability for the outcome being realized in due time.

Figure 1: Mindful Governance model

Thus, in summary, the Mindful Governance model is built around the proposition that the obligation to act is a basic precondition of good governance at all levels from the operational sharp end to strategic management. Six principles define the conditions for realising the obligation to act in a way that works throughout the system at all levels from local performance management to the strategic management of risk.

The principle of relevance contextualizes data and information within the overall operational space, allowing large amounts of data, from planning and operations, to define events and actions around common dimensions, and providing a framework for the feedback of relevant information that can stimulate appropriate action.

Leverage transforms understanding of a problem space from as-is to to-be, identifying what needs to be done. This can be at different levels, for example, locally relevant operational actions as compared to underlying system dimensions that may need to be improved.

Providing relevant knowledge of what needs to be done is predicated on a distribution network of who needs what knowledge when in order to inform action – this is Distributed Authority. This combination of the right people knowing what to do begins to generate a compelling obligation to act on that knowledge.

Accountability involves making the link between action and outcome fully transparent. This reinforces the reciprocal character of the obligation to act amongst all the users of the information system. The corollary of well-informed action is to ensure that that action and its consequences in turn generate information that is shared.

Applying these principles allows for escalation in two ways:

- Horizontal escalation extends the gathering of information across the whole operational space according to where risk-inducing interdependencies can be found. This can often cross organizational boundaries, in which case getting knowledge and leverage over shared risks creates an incentive to collaborate.
- Vertical escalation extends accountability from the lowest operational level to the highest level of regulation and oversight. The transparency of action and outcome at all levels is the basic building block of a strategic risk management capability that is founded on evidence of effective action.

4. Methodology

The multiple-case study method was used to support the application of the mindful organising model. Multiple case studies give contrasting but complementary opportunities to develop and explore this concept in practice (Yin, 2009, 2012, 2014). The use of multiple cases strengthens the results by replicating the patterns thereby increasing the robustness of the findings (Yin, 2012). The selection of the cases followed a criterion and convenience strategy (Shakir, 2002). This included two case-organisations: an ATC and an airline. To be able to compare and 'replicate' the findings, a structured process and procedure was adopted. First, the general methodology of the two case studies is presented. Secondly, a set of theoretical propositions is defined which guided the field research design, data collection and analysis. Thirdly, a generic structured intervention framework is outlined which indicates three initial stages in a sequence for realising system improvements. Fourthly, general principles for multiple case study analysis are provided.

What is reported in this paper essentially comprises the first three high-level steps of an action research implementation programme. These comprise the definition of the problem, specification of requirements for a solution, and the specification and development of a set of prototypical information tools which can facilitate the solution. It is the flow of information around the organisation (and even beyond its boundaries) that is core to the organisational mindfulness concept. Hence it is logical that part of the solution may involve augmenting that information flow. Further development of these case studies may be reported in due course.

4.1 The two case studies

In 2016, field research was carried out in two case studies – involving an Air Traffic Control Organisation and an airline ground operations department – that supported the collection of requirements and data for the further development and testing of the model. This involved an action research iterative process, with the involvement of front-line operators, middle managers and top managers.

In the ATC case study (Callari et al., 2019), the research design involved semi-structured interviews with nine air traffic controllers and four supervisors or managers, plus direct observations of the operations room and analysis of documentation and information tools in use and organisational charts and job descriptions. This then led to a co-design process of a prototypical web-based application for gathering and circulating operational narratives. This was an iterative design process in which the principles of Mindful Governance were built into an initial design, which was progressively refined through feedback from potential users.

In the airline case study, the fieldwork comprised semi-structured interviews with ground operations management and supervisors, analyses of safety reporting and documentation systems, and finally an analysis of a series of operational audits of the aircraft turnaround process. This led to the prioritisation of a particular organisational initiative. In order to support that initiative, two prototypical web-based applications were developed: a generic reporting process that could incorporate and extend existing safety reports; and an 'improvement manager' software system designed to support improvement projects. Again, this was an iterative design process in which the principles of Mindful Governance were built into an initial design, which was progressively refined through feedback from potential users.

4.2 Definition of theoretical propositions guiding the field research

The theoretical propositions are necessary elements in case study research in that they serve to define the boundaries of the scope of the study. Each proposition conveys a distinct focus and purpose and helps guide the research design, data collection/analysis and discussion. The theoretical propositions can be raised from a literature review about the target phenomenon, or, as in our case, from the Safety Mindfulness principles/components, as described in Section 2 – Applying the Safety Mindfulness model. Hence, each Safety Mindfulness component has been operationalized, into possible statements to guide the application of the model in the two case studies (see Table 3 below). Overall, the model follows a holistic approach – i.e. all components are inter-linked, so that the application of each supports the so-called 'obligation to act'. Mindful organising creates the conditions that encourage informed and accountable action at all levels across the system. This enables both feedback and accountability to stimulate the highest possible levels of performance, hence an 'obligation to act'.

Table 1: Multiple-case study theoretical propositions

Potential Theoretical Propositions	Source **Mindful Governance model

[organizes data and provides context for action] • The generation of safety-critical logs/ experiences/ narratives from oneself and others is relevant and sufficiently important for legitimate users • The information spread is relevant and sufficiently important for legitimate users (i.e. top, middle, sharp-end people) to merit attention, and comment (if the case) • Legitimate users are informed with relevant information that primes one's expectations of potential issues that might arise even if highly unlikely	RELEVANCE
[transforms understanding to identify what is it to be done] • Each safe project includes structured steps of intervention to enhance the system's capabilities to remain safe • The shared knowledge is used to improve the functioning of the system • The value of the 'knowledge in use' impacts on the system, through better operational performance, and effective improvement actions • Safety-critical projects are managed and show a clear structure/steps of intervention to enhance the system's capabilities to remain safe	LEVERAGE
[supports informed action] • The solicited and gathered information that is worth sharing, processing and distributing supports the planning and action of individuals across the system	DISTRIBUTED AUTHORITY
[creates transparency of action and outcome] • The flow of information generates awareness that supports appropriate action (at operational or management level), producing outcomes. • Making this cycle (knowledge – action – outcome) transparent both validates the knowledge and makes the actions accountable • It's about the 'action', and the consequence of that action – i.e. to enable people to act in the proper way, and evaluate the impact of that • Mindful organising creates the conditions that encourage informed and accountable action at all levels across the system	ACCOUNTABILITY
[extends across the whole interdependent operational system] • There is a sufficiently large number of operations generating relevant safety-critical logs/experiences from oneself and others to allow aggregation across a large number of operations • Aggregation across a large number of operations holds the possibility of generating sufficient relevant safety-critical logs/experiences that can pose the question: 'how well did we deal with all risks that we confronted/faced either directly or indirectly? • There is attention on interactions across boundaries, where propagation of variance and uncertainty can escalate problems • There is a focus on operational interdependencies between different parts of the system, thus enabling a 'whole systems' approach (horizontal escalation)	HORIZONAL ESCALATION

[extends accountability from operation up to regulatory authority] • Mindful organising information creates a 'cascade' of accountable activity across all system levels – strategic, tactical and operational • By creating accountability for jointly managing shared risks mindful safety information enables effective reporting relationships across the system from top (strategic and regulatory) to bottom (operational)	VERTICAL ESCALATION

4.3 Applying an intervention framework

The conceptual framework serves as an anchor for the way the study will be realised. Further, it becomes the vehicle for generalizing to new cases. It supports the strategic level of controlling action of the researcher to specify the stages of the project -i.e. from the problem definition, into the validation, through the solution, plan/development, implementation, and verification). Within each stage probes of tactical level of managing action and consequences are defined. This includes (1) the context; (2) the mechanism; (3) the outcome. The Table below offers an example of the breakdown of the first three phases (i.e. defining the problem, identifying solutions, and planning/developing ideas/ tools that would become part of the overall solutions).

Table 2: Breakdown of the tactical level of managing action and consequences, with probes

Strategic level	Tactical level	Probes
PROBLEM	Context	*What is the problem context?* *Who and what is involved, when and where?*
	Mechanism	*How did/does this cause the problem?*
	Outcome	*What is the outcome (actual or potential)?* *What outcomes have happened/could happen as a result?*
SOLUTION	Mechanism	*What could solve the problem?* *What else should change to support this?*
	Context	*How could the problem cause be effectively addressed?* *How effective would this be?*
	Outcome	*What outcomes would result?* *What else would need to change?*
PLAN/DEVELOPMENT	Outcome	*What are the critical outcomes that need to be achieved?* *What outcomes would result?*
	Mechanism	*How will they be realized? What else needs to change to support this plan?*

		What are the critical measures that need to be implemented? Technologies, processes, procedures, structures, standards, etc. Human resources Information systems *How will they be implemented?* Who, when, where
	Context	*What are the objectives that need to be achieved?* *What actions need to be taken to create a supportive context?* Prepare the ground Reinforce the effectiveness Sustain implementation What cultural values & norms could impact on implementation?

4.4 General principles for the analysis of multiple case studies

Each case study consisted of a 'whole' study, where the findings indicated how and why the theoretical propositions was demonstrated or not demonstrated.

Across cases, the multiple-case findings will indicate the extent of the replication logic and whether the cases were able to predict/confirm certain results. The specific findings from the single cases will be converged in an attempt to understand the 'overall case'.

Case study methods involve using multiple sources of data and triangulation of evidence. Yin (2009, 2013) claims that in the context of data collection this will support the corroboration of the data gathered from other sources. Yin (2012) describes five techniques for analysis: pattern matching, linking data to propositions, explanation building, time-series analysis, logic models, and cross-case synthesis. A systematic research process definition and traceability ensures validity and reliability (Callari, McDonald, Baranzini, & Mattei, 2017; McDonald et al., 2016; Saldana, 2012).

5. Application of the model in the two case studies

The underlying principles of the Mindful Governance model -as it has been consolidated -have provided the basis to design potential IT solutions/apps that would facilitate the flow of information.

5.1 Case study 1: ATC organisation

Summary of the field-work analysis

The core of the development of this case study was the analysis of a set of interviews and focus groups carried out in an ultra-safe Air Traffic Control centre (Callari et al., 2019). The focus was on

how ATCOs are sensitised to detect and manage unwanted events, how the system develops collective problem-solving capabilities to face the unexpected and promptly react to it in a variable manner, how real-time communication and flow of information is promoted. The challenges faced by this analysis were to coherently relate the experiences expressed by the participants to the broad underlying components of mindful organising, namely: (1) mindful infrastructure, (2) respectful interaction, and (3) heedful interrelations. While these concepts reasonably accounted for much of the expressed material, it was also true that these theoretical constructs had to be grounded in particular practical contexts, particular ways of working, the operation of specific systems, etc. It was also the case that some of the material did not easily fit within these constructs and this extended the analysis under the headings 'Accountability' and 'Co-ordination between groups'. These two concepts begin to locate mindful organising within an organisational system. Accountability brings to the fore reporting relationships within some kind of bureaucracy or hierarchical system. Co-ordination between groups highlights the interdependencies between different units within an operational system.

The main results can be briefly summarised as follows. There were some concerns about the collective opportunities in which they could raise and discuss operational issues, due in to changes in the rostering pattern and in training provision. In relation to the information flow, there were issues expressed concerning the usability of current systems for gathering and accessing safety information. Communication back to the controllers is both informative of current issues and formative in extending their knowledge. However, the analysis concludes that the flow of information about safety in operations may not be as rich and free flowing as is implied in the principles espoused by Weick, Sutcliffe and others. The following summarises this essential conclusion. The current system is designed to be self-manageable, i.e. it is the responsibility of the ATCO alone to (a) read and understand, and (b) learn and apply the content contained in the above types of communication means, and offers less regular opportunities of formal sharing and discussion. Overall, the current information flow in the ATC is very safety-focussed, traceable and systemic, but we argue that its circularity (i.e. feeding in and feeding out) has been attenuated given the change in the rostering. The mindful organising construct focuses on facilitating social processes able to detect and correct errors and unexpected events, but it does not provide clearer guidance to help identify countermeasures and/or solutions to support a purposeful circular flow of safety-related information that actively supports people's capability to act (i.e. they are accountable of their actions) to fulfil their particular role and authority (at whatever level).' (Callari, et al, 2019)

This suggests that even in an ultra-safe organisation it is possible to improve the flow of information to promote mindful organising – indeed it is one of the hallmarks of such an organisation that it would actively seek opportunities to do so. Several implications follow from this. The flow of information does not just happen spontaneously in a large and complex organisation. The opportunities are enabled and constrained by the ways in which work is organised and changes in this organisation may have unintended consequences that need to be addressed. Information systems define much of the information that is generated and determine how it flows and is used. Is the system really concerned with how information is used, or is it enough to know that information has been transmitted to relevant

users? If we want to know whether information is useful and used, it is necessary to have some kind of feedback loop. Circularity in the flow of information seems to be a fundamental principle to ensure validation. If we build feedback, we can bring action into the equation – what was done and to what effect? This then raises the questions: actions by whom, and where, across a large distributed system? The flow of information that is core to the mindful organising concept needs to be designed, developed and implemented, according to practical principles that enhance the effectiveness of the organisation as a whole. And this in turn poses the interesting question: how can the apparently spontaneous self-organising activity that is implied in the mindful organising concept be enabled and promoted by a system of governance?

A mindful organising application for Air Traffic Controllers

This application would capture the safety-related events that are not recorded in existing systems – the ones that currently remain in the ATCOs' "head". To do so, ATCOs should be motivated to share all their experience with their peers. These experience-records would include very concise and meaningful information with concrete applications, pictures and videos to support/facilitate the leverage of the learning process. The story-telling related sections will comprise a meaningful title, and the story body-structure, following a narrative structure and a section for the provision of "Recommendations". This gives the opportunity to share the ATCO's experience and expertise in a more formalised way. This can include (1) previous 'resolutions' from the technical group and as a consequence the ATCO will share this with the wider group; (2) a recurrent safety-critical event that has been experienced by the ATCO (e.g. the ascendant speed/trajectory used by a specific airline when taking off); etc. An existing record can be retrieved using possible filters, like type of sector, airline, keywords, title text query, or anything that the ATCO would include as critical for the selection criteria. It should include an 'Add comment' open box, within which the ATCO can share his/her experience on the topic selected. We believe that this is critical to strengthen the ATCOs' mindful organising and continuous learning from peers' experiences.

5.2 Case study 2: Airline ground operations

In the airline the evidence from Ground Operations data and reports shows that direct and indirect costs of Ground Handling related damages have significant impact on the company business. Safety can be compromised in several ways during the aircraft turnaround at the airport, especially in relation to "Aircraft damage" events caused by ineffective performance. The company had introduced an operational audit of the turnaround process and the opportunity was taken to analyse the data from this audit at one airport.

A Big Data study was carried out using predictive analytics (performed with machine learning methods in IBM SPSS-22). Logistic functions models revealed a high number of audit failings and features predicting the occurrence of safety events, as target events. Results are based on all audit data and safety events over all 2016 and part of 2017. Binary and multinomial logistic regressions were fitted to the data samples successfully. Safety events like Ground Handling Damage were classified over a set of vector predictors where reliable sub-sets of such predictor features were

detected with significant parameters (odd ratios) increasing likelihood of Turnaround performance as well as Ground Handling Damage occurrence. General findings were that only 57 (15,2%) out of 375 flights delivered 100% positive turnaround performance (no negative marks out of 50 indicators available). More the 45% of all Turnarounds got between 7 and 15 negative marks per single Audit.

The results of predictive models (logistic functions) showed that the audit item “Is pre-arrival briefing conducted with all stakeholders?” is one of the most important GO Audit indicator that predicts the largest volume of “subsequent” GO Audit negative findings. Shown in Table 3 below is that the turnarounds with higher volumes of negative performances (>9) are 12 times (column Exp(B)) more likely to be carried out without proper pre-arrival briefings.

Table 3: Parameter estimates

Parameter Estimates

Imputation Number: Pooled

Volume Negative Performance (no 12) (Binned 1 2-8 9)[a,b,d,e,f,g]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)		Fraction Missing Info.	Relative Increase Variance	Relative Efficiency
								Lower Bound	Upper Bound			
2 - 8	Intercept	-2.174	0.520	17,491[h]	1, 9,586	0.002				0.629	1.270	0.864
	[New12=0] NO BRIEFING	1.309	0.821	2,541[h]	1, 6,179	0.161	3.703	0.503	27.228	0.763	2.298	0.840
	[New12=1]	0[b]		.[h]	0, .							
	[NewSeason3=1,00] Winter	3.321	0.970	11,711[h]	1, 5,304	0.017	27.686	2.384	321.518	0.812	3.033	0.831
	[NewSeason3=2,00] Spring	2.616	0.671	15,205[h]	1, 8,189	0.004	13.677	2.930	63.840	0.676	1.533	0.855
	[NewSeason3=3,00] Summer/Autumn	0[b]		.[h]	0, .							
	[NewAircraftType=1] ATR/Embraer	0.916	0.626	2,145[h]	1, 10,900	0.171	2.500	0.630	9.927	0.593	1.104	0.871
	[NewAircraftType=2]	0[b]		.[h]	0, .							
9+	Intercept	-5.197	1.057	24,168[h]	1, 49,143	0.000				0.276	0.328	0.935
	[New12=0] NO BRIEFING	**2.491**	**0.807**	9,526[h]	**1, 7,218**	**0.017**	**12.075**	1.812	80.477	0.714	1.814	0.848
	[New12=1]	0[b]		.[h]	0, .							
	[NewSeason3=1,00] Winter	**6.042**	**1.304**	21,487[h]	**1, 14,465**	**0.000**	**420.826**	25.917	6833.236	0.518	0.836	0.885
	[NewSeason3=2,00] Spring	**5.654**	**1.082**	27,278[h]	**1, 43,125**	**0.000**	**285.346**	32.163	2531.523	0.296	0.358	0.931
	[NewSeason3=3,00] Summer/Autumn	0[b]		.[h]	0, .							
	[NewAircraftType=1] ATR/Embraer	**1.203**	**0.539**	4,988[h]	**1, 40,908**	**0.031**	**3.332**	1.122	9.893	0.304	0.371	0.929
	[NewAircraftType=2]	0[b]		.[h]	0, .							

a. The reference category is: <= 1 for split file Imputation Number = Original data.

b. This parameter is set to zero because it is redundant.

d. The reference category is: <= 1 for split file Imputation Number = 1.

e. The reference category is: <= 1 for split file Imputation Number = 2.

f. The reference category is: <= 1 for split file Imputation Number = 3.

g. The reference category is: <= 1 for split file Imputation Number = 4.

h. Significance computed using F distribution, not Chi-square.

Which variable is predicting safety events in GOs like Ground Handling damage? The results as shown in Table 4 describe how predictive models identified a robust predictor in the Audit performance: the Audit performance levels predict the likelihood of occurrence of GO Safety Events (Ground Handling Damage or Incorrect Loading). The GO Safety Events are 4 times more likely (Exp(B) column in Table 4 below) to occur for very negative Audited Turnarounds (more than 6+ negative marks per single Audit; TOTNEG4(2) in Table 4) with respect to moderately negative Audited turnarounds (<5 negative marks) which, in turn, do not predict GO safety events occurrences. The Audit and Safety Events show a non-linear relationship: highly negative turnaround performances increase the odds of incurring in safety event, but this odds increase disappears for moderate or lower levels of turnaround performances. The interpretation of this analysis is that pre-turnaround briefings are critical in ensuring both effective and safe performance. This is a critical issue for mindful organising the operation.

Table 4: Parameter Estimates of precursors predicting Safety Events in GO

Variables in the Equation

Imputation Number: Pooled

		B	S.E.	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Fraction Missing Info.	Relative Increase Variance	Relative Efficiency
Step 1[a]	TOTNEG4(1)	-0.002	0.816	0.998	0.998	0.201	4.947	0.056	0.058	0.986
	TOTNEG4(2)	**1.413**	**0.672**	**0.035**	**4.110**	1.102	15.334	0.030	0.030	0.993
	NEW_Season2(1)	0.076	0.361	0.834	1.078	0.531	2.190	0.015	0.015	0.996
	NewAircraftType(1)	-0.300	0.402	0.456	0.741	0.337	1.630	0.010	0.010	0.997
	Constant	-3.107	0.650	0.000	0.045	0.012	0.160	0.038	0.038	0.991

a. Variable(s) entered on step 1: TOTNEG4, NEW_Season2, NewAircraftType.

Other operational issues in Ground Ops relate to the mandatory reporting processes. In particular there is a high frequency of problems and delays in ground operations reporting. The ground safety reporting (GSR) are not sufficient and user-friendly to cover all important issues in turnaround operations. A clear loss of Safety Mindfulness capacity is reported by ground operations managers (receiving the GSR in the office), as well as by the operational people inputting the reporting. Put simply, the quantity and type of safety information managed with several GSRs is not effectively shared and utilized across the various job functions and roles. This hinders the elicitation of shared/collective mindfulness within the Ground Ops.

A typical GSR takes too long to complete as there is too much information and data to fill in in more than 50 fields – several descriptive data items amounting to more than 30 fields could be pre-compiled by automation. The Reporting problems are not always reported: there is evidence of incomplete or ineffective reporting. Compiling a normal GSR may take from 15 to 20 minutes if all relevant sections and information is entered.

Notably, there is no dedicated process to implement improvement solutions. Different departments do not collaborate effectively to ensure progressive improvement in operations – the evidence is that they use the “read & sign” procedure to implement and control implementation of solutions. Very easily, any manager approves by signature that the actions required to him to implement a solution (written generally in a formal email or documentation) will be implemented, implying that these have been read and understood for implementation. No other step is required, leading to an informational gap on the real conditions of follow ups or status of solutions.

These findings suggested a new initiative designed to promote Safety Mindfulness capacity and increased maturity by ensuring effective “First Phase Turnaround Operations” (e.g., Pre-turnaround briefing in all ground operations). This is to facilitate the effective multi-level flow of safety knowledge in terms of reporting, solutions and implementation of changes (the overall process) in compliance with regulations, procedures and safety standards, without compromising overall operational efficiency – lean, safe, and accountable operations.

Two key objectives are indicated by the Airline ground Operations case: 1) increase mindful organising levels and capacity and 2) facilitate the implementation of a wider organisation improvement initiative. These would be supported by two complementary initiatives: (1) introduction of a 'new reporting system" to help identify occasional and recurrent factors that interrupt safe and efficient performance; (2) an enhanced management process to oversee this improvement initiative supported by an 'Improvement Manager' software system.

Torrent Reporting system

The main idea behind the reporting system is to create a tool that allows the operator to report simply and quickly information and, at the same time, allows the operator to suggest corrective actions. The tool provides a simple project management section for handling the corrective actions because it is important that every open issue gets its corrective actions implemented and closed.

Once the corrective actions are implemented the final step is to notify the reporter about the closed issue in a way that he/she is encouraged to report again in the future.

Improvement manager

An improvement initiative is a complex process that involves many people and often has the time window of months or maybe years. It is important to have a tool that supports the operations in order to keep everybody updated and avoid that the day-to-day activities overcome the initiative. An initiative generally is inter-departmental and requires the attention of different managers. In a complex organization different departments are involved at different phases – e.g. the initiative may start in a safety or risk department (defining the problem, making recommendations) but continue in an operational department (planning and implementing change) and return to an audit department for verification. A primary function is to help the user to keep track of what is happening: the improvement initiatives, in which the user is participating, invitations to other initiatives and public updates about other initiatives the user is not directly involved in. A procedure supports the handover and the negotiation that happens when an initiative goes from manager to manager. Each phase has a panel that helps the manager and all the other users to follow the operations. Each phase has a public section. This allows the manager to share information with the rest of the organization but also to give the manager the control about the information that is shared. The public (in terms of the organization) content helps to encourage the exchange of knowledge and information, in order to exit the silos and collaborate even between different departments. The public content allows comments. Sometimes managers of different departments are facing the same issues. The comment area helps to share experiences and to keep a spirit of collaboration across different departments.

6. Conclusions

The Mindful Governance model is based on a simple concept: if people are provided with relevant information and support, and made accountable for their actions, this creates a compelling obligation to act to solve the problems they face. This principle can be applied at all levels of the system and

across all the interacting interdependent systems that generate shared risks. This creates a virtuous cycle that adds value through verified outcomes.

Applying the mindful organising principles implies being well informed, using one's knowledge and understanding in a deliberate and focused way and always being alert to new relevant information that can inform one's professional judgement.

Developing the mindful organising construct involves developing and mobilizing the collective knowledge of the organization to actively support this kind of mindful organising amongst its members and those they work with. In this way the organization can be said to have 'a collective mind' and can act mindfully as an organization. Within this concept, mindfulness is more than just a 'state of mind' – it involves an intention to act and to carry through that action, mindful of the consequences. In fact, seeking to optimize the consequences. This action can be at local level in playing one's operational role or it can be at a management level in carrying out a traceable improvement initiative, for example. It is this action, these actions collectively, that provides the key evidence to reinforce an renew to mindful organising – what happened, what was the outcome, what was the context – this is what we need to share with others in order to understand how to act more effectively, mindful of the context of our action and the consequences that could follow.

The opportunity is thus to construct a seamless information flow and transformation to create a self-regulating productive governance system. This is based on a simple concept: if people are provided with relevant information and support and made accountable for their actions, this creates a compelling obligation to act to solve the problems they face. This principle can be applied at all levels of the system and across all the interacting interdependent systems that generate shared risks. This creates a virtuous cycle that adds value through verified outcomes.

Mindful Organising is a key integrating concept in resolving the organisational accident. It represents the sense-making role of people at the operational sharp end.

- Mindful Organising is both the unique source of critical information about the normal operation – what went well (i.e. actions that were effective and are shared) and what could be improved
- as well as the key recipient of intelligence about the operation, ensuring that operational actions are always informed by the most current, relevant information about potential risks no matter how remote.

It is this circulation of information and knowledge throughout the organisation that is at the heart of the original conception of organisational mindfulness of Weick and Sutcliffe, but which has never been operationalised as a practical and effective approach for complex ultra-safe systems.

This concept has been reworked to reinforce the idea that mindful organising is more than just a state of mind; it is about the gathering and flow of information to ensure awareness and appropriate action, both at the operational level and amongst middle management in ensuring improvements are effectively implemented. A novel Mindful Governance model has been advanced which provides an organisational context for its implementation, based on the behavioural-economic principle that being

well informed about an issue, having an effective and practical solution and being accountable, creates a compelling obligation to act in an appropriate manner.

Two case studies have been used to simulate the model using a multiple-case study approach:

1. Air Traffic Control Centre: This demonstrated the need for the gathering and circulation of potential risk related narratives amongst air traffic operational staff in order to heighten safety mindful organising in this ultra-safe sector, ensuring effective feedback loops of relevant information into the operation. A prototype application was developed to address this need.

2. Airline Ground Operations: 'big data' risk pattern analysis of audit reports identified poor pre-turnaround briefing as a precursor of other operational failures which in turn were associated with actual safety incidents. This has initiated a case study centred around improving turnaround briefings and mindful performance. Two prototype applications were developed to enhance reporting and the mindful management of improvement projects.

These case studies represent the first stages of full action research implementation. Even at this stage they demonstrate the value of a multiple case study approach. Contrasting operational locations within the same industry allow different opportunities for data collection and analysis; in turn, these indicate a different scale and focus of problems; yet these diverse problematics can both be coherently related to a common model of Mindful Governance in such a way as to lead to the development of a suite of prototypical applications to support interventions to address the underlying problematic. The story will continue as and when the next stages unfold in these and other case studies.

The work represented in this paper and in Callari et al. (2019) is part of an extended research and development trajectory to build an effective, practicable and theoretically rigorous approach towards the governance of operational risk. The strand of argument represented here seeks to operationalise the influential mindful organising concept of Weick and others. It is also relevant to theoretical concepts like Safety II which contain a strong critique of conventional safety management (Safety I), but does not have the theoretical leverage to propose effective solutions to the problem (Hollnagel, 2014). Likewise, authors like Braithwaite et al. (2018) invoke the notion of complex adaptive systems as a way of explaining the vagaries of organisational and operational change in healthcare, but again, this provides no concrete or practical guide to action. Models of governance that can encompass the management of large amounts and diverse sources of information, and multiple implementation projects are one potential way of addressing the challenges of strategically managing risk in complex operational systems (McDonald and Ulfvengren, 2019). Demonstrating the effectiveness of the solution requires an extended process of development and implementation. Theory and practice are thus inextricably intertwined in a complex journey which has yet some way to go.

Conflicts of interest

The authors have no conflicts of interest to report.

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